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CACTUS AND SUCCULENT JOURNAL

Vol. XXIX JULY-AUGUST, 1957 No. 4

FIG. 55. Paul C. Hutchison, Senior Botanist, Botanical Garden, University of California, Berkeley. The photo, by Rudolpho Wagenknecht, was taken in 1951 in the Andes east of Coquimbo. The plant is a golden-spined species of *Eriosyce*, the coloring very similar to that of *Echinocactus grusonii*.

CACTUS AND SUCCULENT JOURNAL

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SIXTH EXPEDITION TO THE ANDES

The University of California Botanical Garden Sixth Expedition to the Andes will take place during 1957-58 under the direction of Dr. T. Harper Goodspeed, Director of the Botanical Garden and Professor of Botany. Paul C. Hutchison, acting as botanist for the expedition, will leave from San Francisco airport July 19, just two days after the close of the Seventh Bi-ennial Convention of the Cactus & Succulent Society of America, of which he is Convention Chairman. Hutchison will fly to Lima, Peru, with William H. Marshall of Berkeley as assistant and photographer for the expedition, and there will pick up a new 1-ton Ford truck and supplies previously shipped by sea from San Francisco. For four months collecting will be done in all parts of Peru from the Ecuadorian and Bolivian to the Chilean frontiers, with primary emphasis on collections of cacti. At the close of the expedition, November 18, Hutchison will fly to Bolivia, Chile, Argentina, Uruguay, Paraguay and Brazil, for further herbarium and field studies, returning by Venezuela, Panama, Guatemala and Mexico. He expects to arrive back in Berkeley about December 31, 1957.

Other phases of the expedition will be conducted in Chile and Argentina. Dr. Goodspeed and the other collectors for the expedition will leave somewhat later in the year and probably will return in 1958.

Hutchison hopes that material collected on this expedition will help to clarify the status of many species and several genera of cacti in Peru. He will collect living material and seed as well as pressed and pickled plants. A number of the species will be drawn, following the style of presentation of those already published in his series of articles in this JOURNAL, Icones Plantarum Succulenetarum, and these illustrations will ultimately appear in the treatment of the Cactaceae in J. Francis MacBride's "Flora of Peru" currently being published by the Chicago Natural History Museum.

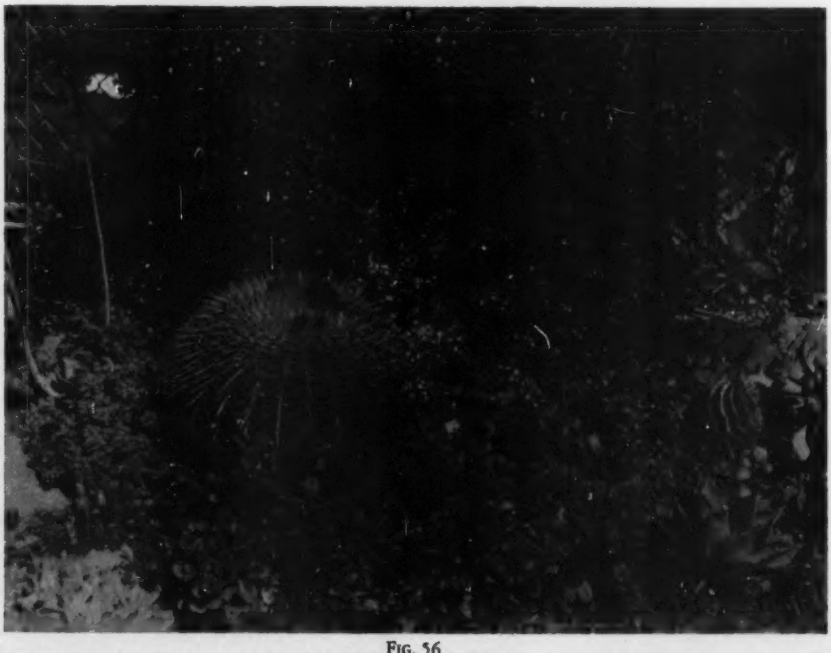


FIG. 56
An informal planting of cacti and other succulents. A golden spined *Echinocactus grusonii* is set off with *Portulacaria afra* as a background. Color effects are always harmonious and interesting.

Lateral Tip Grafts and Chimeras

Since last fall I have made several cactus grafts of a type new to me. The essential feature consists in splitting the tips of the stems through their centers and joining the meristems of stock and scion laterally (Figs. 1, 2, & 3). The hope is that the united stems A and B will fuse while they grow into a common stem with a meristem formed from both A and B cells. Such a plant is called a chimera from the mythological creature which was part lion, goat and dragon (Fig. 4).

Fig. 1 shows the method I have used most frequently since it is only necessary to choose plants which have nearly the same shape and diameter at the end of their stems. In Fig. 2 it is more difficult to find suitable plants and there is the danger of infection and damping off as each plant is split its entire length. Fig. 3 shows a sort of inarching; this causes less shock to the plants and more rapid growth, but it is more difficult to make properly in my experience and one gets only one graft out of two plants. Fig. 5 is the last type I have tried. Stems A and B are chosen of closely the same diameter (over 1 inch) and cut the same length, then split and united as shown; it is the simplest to make, but one has to wait for roots to form before planting.

I have used Gillette blue blades making the first cut downwards through the center to the desired depth and cutting horizontally with another blade to hit the first blade at its lower edge in Fig. 1. The scions are then swapped and tied in place with rubber bands (Fig. 6). Applying the rubber bands is the tricky (and pricky) part of the whole business. Pressure should be firm, but not so great as to throw the tips out of alinement. It is better to keep the grafted plants in a moist atmosphere to reduce shrinkage from evaporation and out of the direct sun. Separation at the edges is apt to occur if bands are removed early. I have kept some on for 4 months to see what might happen without harm so far. The best union as one would expect is at the tips for here is the greatest amount of cambium tissue.

It is important to split the tips exactly through the center. What happens when the cut is too far to one side is seen in Figs. 7 to 12. In Fig. 7 and 8, A and B both have enough central meristem to reorganize their own growing tips and so no chimera. In Fig. 9 and 10 we see that B forms a growing tip which drags up some of A along with it. In Fig. 11 and 12 neither A nor B have enough central meristem to form their own tips independently, at least right away. Whether they can later make a combined effort sufficient to produce a common meristem from which a chimera will grow remains to be seen.

Chimeras have been produced in other plants and there is no theoretical reason why they cannot occur among cactus grafts. It may be easier to form them from other plants where it is easier to obtain adventitious buds from callus tissue. Possibly one might get them from fleshy root grafts. In one sense the variegated plants: geraniums, ivies, tradescantias (Wandering Jews) are chimeras. There is even a variegated cactus, Opuntia vulgaris variegata (Joseph's Coat). In these plants the outer layers of the meristem are unable for some reason (intracellular virus?) to produce chloroplasts so that the stems and leaves are white on the outside—white edged leaves; or the white may be covered by the green-edged leaves with whitish centers. These might be called, periclinal types. In the variagated Tradescantias the leaves are always streaked lengthwise. In the variegated Opuntias the white and green may get quite mixed up and would correspond perhaps to hyperchimeras. I enclose a quotation on this subject.

"Graft Hybrids and Chimeras

"It has often been supposed that the stock and scion sometimes fuse in such a way as to produce new shoots that are intermediate between the two graft symbionts; such new forms have been termed graft hybrids. Famous cases of supposed graft hybrids are: the Bizzaria orange, which is thought to have arisen from a graft of Citrus Aurantium and C. medica; Cytisus Adami, which is thought to have arisen from a scion of C. purpureus on C. Laburnum; and Crataegomes, which is supposed to be a graft hybrid between Crataegus monogyna and Mespilus germanica. A case has been reported where there arose shoots of intermediate character when a pear scion was grafted on a quince stock. Usually seedlings from these 'graft hybrids' revert to one or the other of the two parent forms, but in at least one instance, progeny of intermediate character has been reported; for example, if white beets are grafted on red beets, about a fourth of the progeny of the white scion is red or reddish.

"Recently a remarkable fusion of the stock and the scion has been produced by a graft between the tomato (Solanum Lycopersicum) and the nightshade (S. nigrum) in which a bud de-

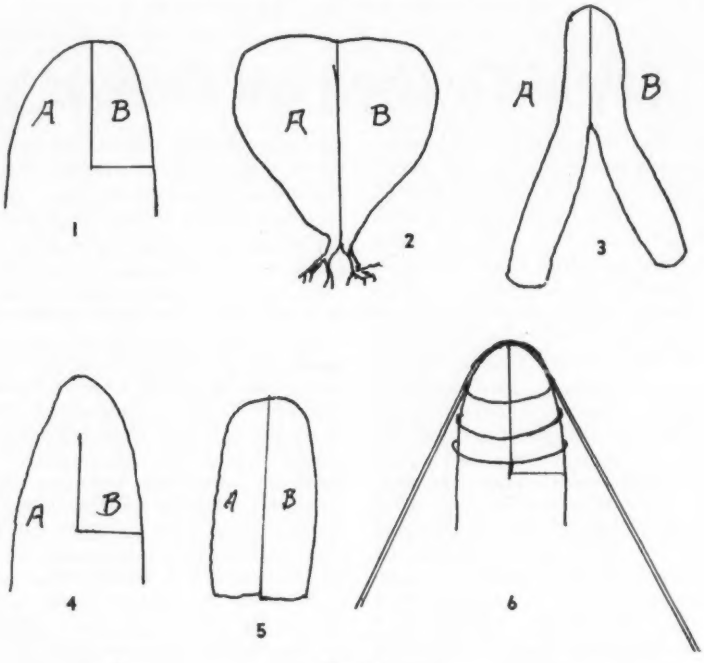
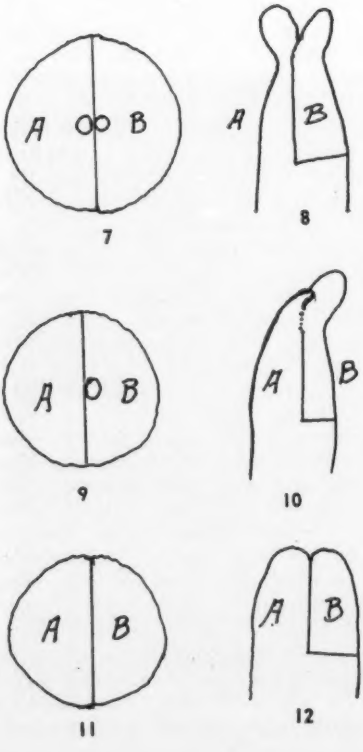


FIG. 57



veloped where the two calluses fused, growing subsequently into a shoot that combined the characters of both stock and scion; to the new form thus produced there was given the name Solanum tubingense. Several such forms have developed, some of which are nearly intermediate between the parent species, while others more closely resemble either the nightshade or the tomato. Seedlings revert to one or the other of the parent forms. Shoots sometimes arise in which a part is like the nightshade and a part like the tomato; such forms have been termed chimeras.

"Much difference of opinion has arisen concerning the interpretation of these striking results. One theory is that the new productions (such as Solanum tubingense), which are not obvious chimeras, none the less resemble the latter in maintaining the individuality of the two components, the portions of each being aggregated into a sort of patchwork or mosaic; the new forms from this viewpoint are regarded as hyperchimeras. Another theory has resulted from a study of forms of Pelargonium with white margined leaves, in which it has been found that one of the graft symbionts may serve as a sort of mantle for the other; the body of the new form is composed entirely of one variety, while the epidermis alone, or the epidermis with the hypodermis, is composed entirely of

the other variety. These remarkable forms have been called periclinal chimeras. Already it has been shown that Cytisus Adami is a preiclinal chimera, the body being composed of C. Laburnum and the epidermis of C. purpureus. There is reason to believe that Crataegomespilus is to be explained similarly. In all these cases, as in Solanum tubingense, a seedling gives rise not to an intermediate form but to a form like one of the parent symbiots. While most of the supposed graft hybrids thus appear to be periclinal chimeras, there are some investigators who still hold to the reality of graft hybrids; in the last analysis a graft hybrid should differ from all kinds of chimeras in the merging of the protoplasm of the two graft symbionts. Such a merger has not as yet been demonstrated."

Quotation from "A Textbook of Botany" by John M. Coulter, Charles R. Barnes and Henry C. Cowles. Vol. II, 1911—American Book Co. p. 779.

If green leaved geranium flowers are crossed with pollen from variegated plants with white edged leaves one gets three types of seedlings: 1. All white seedlings which naturally die young. 2. All green seedlings which never show any white thereafter. 3. Seedlings streaked with white and green in wonderful variety whose leaves may be all white, all green, or streaked lengthwise white and green. Note that none of these first leaves are periclinal chimeras with green centers and white edges or the other way around. Actually this comes later as the white meristem cells overgrow the green. And from the preceding one may infer that the pollen cells and the ovules are derived from an outer layer of the meristem and not from the center cells in geraniums.

Does anyone know if this works out with the variegated opuntias? Would be glad to hear from those interested.

WM. S. CHAPIN, M.D.
2136 Sanford St.,
Muskegon Heights, Mich.

For details on meristems, cambium tissue and stem structure consult any good botany or encyclopedia. I am especially indebted to:

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2. Within the Living Plant by Ernston V. Miller—1953. The Blakston Co.
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7. How to Graft Cacti—by Ladislaus Cutak. Cactus May-June 1955 p. 82.

FIG. 58
Another view of the Moir gardens on the Hawaiian Island of Kauai

STUDIES IN THE TISSUE CULTURE OF CACTI[1]

By R. MERRILL KING[2]

It is quite well known that it is possible to obtain callus tissue from parts of many plants (LaRue, 1936). These tissues, however, are usually derived from plants which are very fast growing or from those that readily form cork tissue when injured. In spite of the fact that cacti seem to possess neither of these qualities, the selection of material was made because of the author's deep interest in this bizarre group of plants.

All work in this experiment was done under as nearly asceptic conditions as possible. All plant material used, was soaked in a solution of twenty per cent Clorox and tap water for a period of twenty minutes to kill any fungal or bacterial contaminants.

Culture media used consisted of White's Solution as the base, plus the modifications listed below.

25 mg 2,4-dichlorophenoxyacetic acid
10% sucrose
20% coconut milk
20% coconut milk plus 5 mg.
2,4 - Dichlorophenoxyacetic acid
20% coconut milk plus 5 mg indoleacetic acid
5 mg 2,4-dichlorophenoxyacetic acid
2 mg indoleacetic acid
25 mg 2,4-dichlorophenoxyacetic acid
25 mg indoleacetic acid

All inoculations were placed on the surface of the media and allowed to develop in the dark room.

Photographs appearing here were taken with a Leica 3F camera with microscope attachment through a Bausch and Lomb binocular microscope.

Plant parts used in this study were the roots, stems, leaves, stamen, pistils, and ovules of the following species of cacti:
Echinocereus enneacanthus (Engelmann), *Cereus hamatus* (Scheidweiler), *Pereskia grandifolia* (Haworth), *Wilcovia poselgeri* (Lemaire), and an unknown species of *Nopalea*[3]. All plants used were grown at the University of Michigan Botanical Gardens. Voucher specimens are deposited in the University of Michigan Herbarium.

Continuing calluses have been derived from both stamen and pistils of *Nopalea* sp. and *Wilcoxia poselgeri*. The calluses obtained were formed on all parts of the pistil. In the case of *Cereus hamatus* the stigman enlarged greatly and curled up somewhat, but failed to form any callus.

In several instances the leaves of *Pereskia grandifolia* were observed to form callus tissue on their midribs and petioles. The remaining portion of the leaf was inactive as to any development, callus or otherwise.

At first the stems of *Echinocereus enneacanthus, Nopalea* sp. and *Wilcoxia poselgeri* exhibited a great reluctance to callus. But after a period of over sixty days, the cells of the pith in each began to enlarge and project outward. A period of dormancy followed this cell enlargement in which no growth activity was observed. This dormant period might be attributed to the warmer weather of the summer as these cultures were not grown at a constant temperature.

In *Nopalea* sp. alone was this period of arrested development broken. The callus tissue has grown at a rate greater than ever before. No excuse for this can be offered.

The best calluses in every case were derived from ovules. When placed in culture they began to swell within a few hours. This swelling was followed by the expanding and uncurling of the funiculi.

The cells of callus tissue derived from ovules are much more compact than those derived from other parts of the plant.

While calluses were obtained from the ovules of *Echinocereus enneacanthus, Cereus hamatus,* and *Nopalea* sp., best results were with *Pereskia grandifolia.* The callus from *P. grandifolia* was whitish in color and quite compact in texture. It was the fastest growing of any of the tissues and was readily sub-cultured.

Chlorophyll formation in the callus tissue was observed in a single culture of *Nopalea* sp. The presence of Chlorophyll might be explained by the fact that a light was unintentionally left on in the dark room at times. It is not known why Chlorophyll formed only in one culture as all of the cultures were grown under the same conditions.

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[1]Paper No. 1044 from the Department of Botany, University of Michigan.

[2]The author wishes to express his appreciation to the following, who aided him in this research: Dr. Carl D. LaRue, Professor of Botany; Dr. Elzada U. Clover, Associate Professor of Botany, and Mr. Richard T. Hanlin, Graduate Student, all of the Department of Botany, University of Michigan.

[3]From a collection made by Professor H. H. Bartlett of the University of Michigan Botany Department, in El Cayo, British Honduras.

FIG. 59 Callus on stamen of *Nopalea* sp

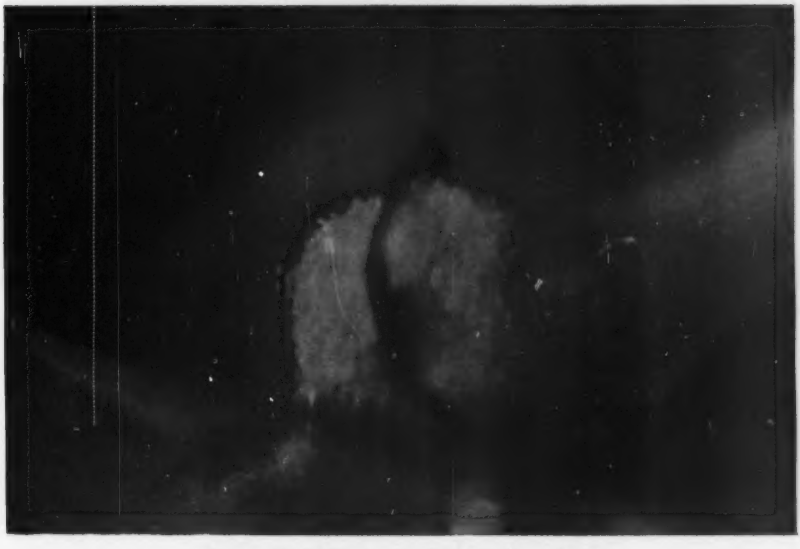

FIG. 60 Callus on stamen of *Wilcoxia poselgeri*

Roots of all species used failed to respond to any solution. Microscopic examination revealed that all callus tissue formed was made up of loosely formed parenchyma cells. No differentiation was observed. The best growth was obtained in every case on White's Solution plus 20% coconut milk and 5 mg. 2,4-dichlorophenoxyacetic acid.

Summary—Five species of cacti tested responded well to tissue culture and callus tissue was derived from stems, leaves, stamens, pistils,

FIG. 61 Ovule callus of *Wilcoxia poselgeri*

FIG. 62 Callusing funiculi of *Pereskia grandifolia*

and avules. All tissue was composed of parenchyma cells. Ovules produced the most numerous and fastest growing tissues. One tissue exhibited Chlorophyll formation.

Department of Botany
University of Michigan
Ann Arbor, Michigan

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PROGRESS IN BOTANICAL ILLUSTRATIONS

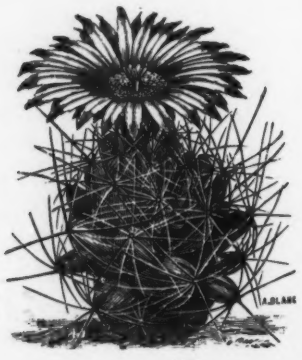
SCOTT E. HASELTON

Reprinted from *Lasca Leaves*

PROGRESS IN BOTANICAL ILLUSTRATIONS

SCOTT E. HASELTON

Pictures, in some form, have been used since the earliest records of man. With their beginning as hieroglyphics chiseled into the rock, to the present day printing of millions of copies of a single picture, we can boast that considerable progress has been made. Illustrations of plants along with religious symbols were among the first subjects used.



Woodcut from Blanc's Catalog of 1880

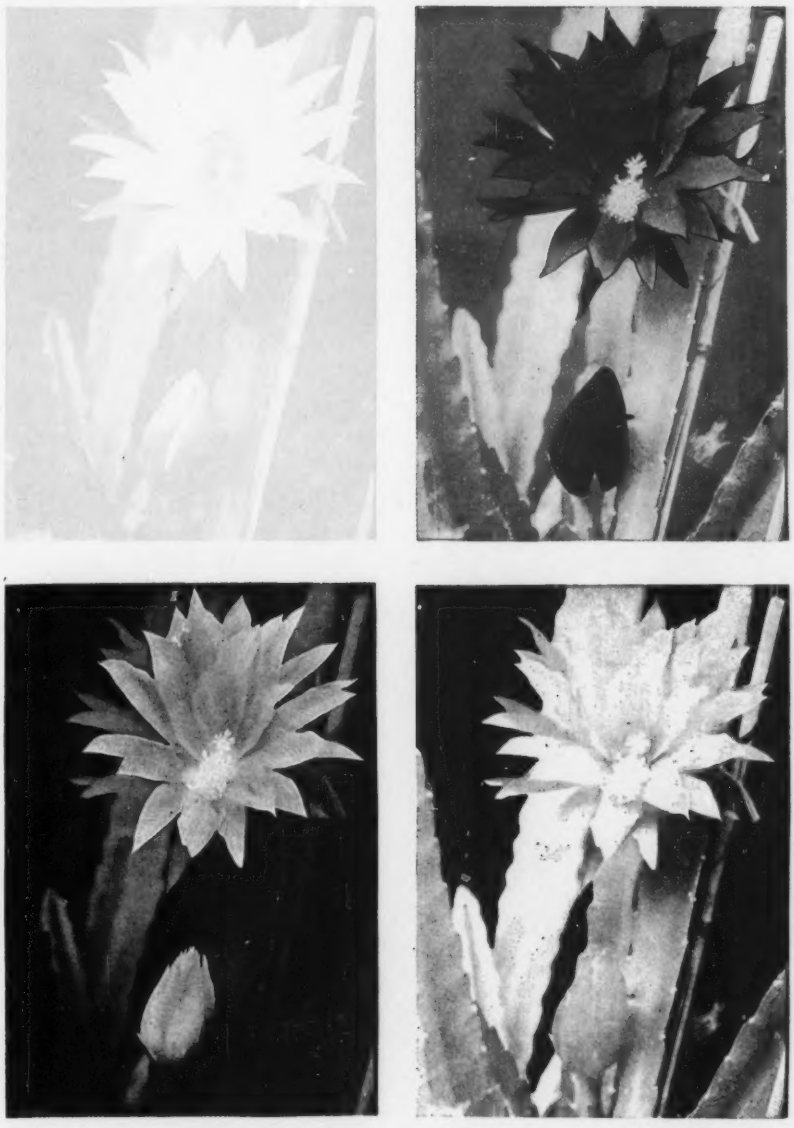
The earliest reproduction process was known as the woodcut which can be traced to the Chinese as far back as 700 A.D. and later to Japan and European countries. This process was the cutting away of the background on fine, side-grain wood and later end-grain blocks of wood, leaving in relief, fine lines and masses to produce in black upon the paper. The final effect would appear similar to a pen and ink reproduction which we use today. The illustrations by the late Alfred C. Hottes which have appeared in *Lasca Leaves* can hardly be distinguished from woodcuts.

Printing from woodcuts in Europe dates back to the fourteenth century. Playing cards were also among the early subjects with the prints hand colored. With the increase of pilgrimages towards the end of the fourteenth century, many woodcut prints of sacred subjects were sold to the pilgrims who took them home to insert into books of devotion or to put upon the wall, thus establishing a private shrine.

The popularity of medicinal plants led to the publishing of herbals which are among our earliest illustrated books. The art of engraving was practiced by goldsmiths who mastered unbelievable fine lines and intricate designs. Even up to Civil War days the intricate war scenes were a challenge to the engravers, many of whom signed their names on the woodcut as do painters of today. Plant catalogs, plant dictionaries, and botanical books were fully illustrated without the aid of any mechanical process in making the printing plates.

While wood engraving was being per-

A four color reproduction from a Kodachrome. See the four steps on opposite page.



Color separations are made so that the primary colors, when printed one on top of the other, result in a full color reproduction.

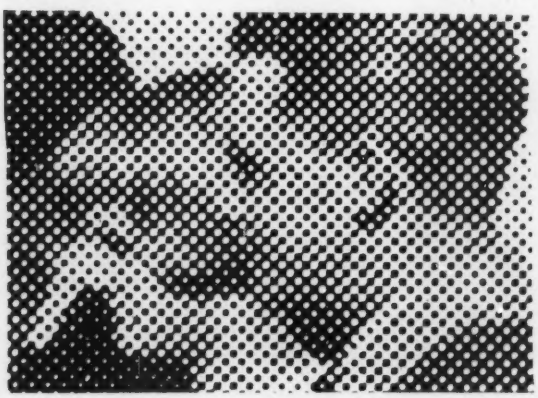
fected, another process and material was taking the place of wood. Copper plates were used in which to engrave the printing lines. The design was incised, not elevated above the printing surface, and when filled with ink gave a relief appearance when applied to paper. These early engravings can be detected by an impression on the edge of the plate or a slight inking of the corners and background. Later these copper plates were etched with acid after the drawings were transferred to the treated copper.

The finest botanical work appeared with the advent of lithography about 1800. This process was the drawing on the surface of a polished stone in greasy crayon. In printing, water and ink were applied; the ink being taken up by the grease while the water covered the remaining surface of the stone. Only the inked portion was reproduced. The cumbersome stones gave way to lighter sheet material and our offset-lithography of today was the outcome of this process. Hand coloring the early lithographed prints was practiced until the appearance of color photography fifty years later.

The development of the photographic process in the middle of the eighteenth century replaced the wood and copper hand engraving and made possible the reproduction of photographs by the halftone process. This chemically etched copper plate is composed of fine dots which faithfully reproduce all tones instead of the black lines of the former processes. The photographs in *Lasca Leaves* are all half-tone engravings.

This present day is not only an age of pictures but now color is a requisite. Hand tinted prints have been superseded by the so-called "four-color process". In this process the subject is broken down into its three primary colors and by printing a yellow, blue, and red plate one after the other, the results are a full color reproduction. One may ask, "Why not make all pictures in color?" The answer is one of simple mathematics—color prints such as were used on the cover of the autumn issue of *Lasca Leaves,* Vol. V. No. 4, cost eighty to one-hundred times as much as a black and white picture.

We can see the progress that has been made in the reproduction of botanical subjects, where pictures are of so much value. We have passed through the tedious stages of hand engraved wood cuts, hand engraved copper plates, hand drawings and the transfer of designs to stone, to the photographic application of pictures on copper with practically no hand work, and now the rendition of subjects in full color. It is difficult to foretell what the next advancements may be but it is a certainty that color will be the dominant factor.



An enlarged section of a halftone to show how a plate is broken into dots.

Cactus and Succulent Growing Tips

By HOWARD E. GATES

Botanically, succulents are watery or fleshy plants in contrast to woody types of plants. However, the term as used in these notes, is restricted to a large and interesting group of plants that store up moisture within their bodies or thick leaves above ground, for use in time of drought. They are usually from arid districts or those that have a definite long annual period of drought. Cactus are succulent plants. Consequently this group should be spoken of, as cactus and other succulents. Not all cactus are leafless and spiny. Some of the other succulents, such as the spherical Euphorbia obesa, do not have leaves. Many other succulents do have spines or thorns. Globular types in both groups are much slower growing than the tall types. Cactus and other succulents may be grown as household or greenhouse plants in every part of our country.

The soil for cactus and other succulents should be very porous, permitting water to drain through rapidly. Most cactus and succulents prefer a neutral soil to one that is either strongly alkaline or acid. We do not recommend the addition of lime unless the soil is known to be very deficient in this element. Many complicated and sometimes useless soil mixtures have been recommended by various authorities. In most cases, a neutral potting soil such as prepared by commercial greenhouses and sold through garden supply centers, with the addition of one part coarse sand to three parts of the soil mixture will be satisfactory. Fresh manures should be avoided. Never plant in pure sand of any type as the plants require nourishment which is not found in sand.

We recommend the purchasing of nursery grown cactus and succulents. They look better and grow more readily than plants collected from the wild. These are usually shipped "bare root", that is un-potted and without soil. The plants must be dry before packing for shipment, to avoid rotting enroute. Upon arrival, the plants should be promptly unpacked, but may be stored dry for a week or more, before replanting. Only those roots that are broken or thoroughly dried out should be removed.

Pots and other containers should "balance" the size of the plant. Plants will not grow well in containers that are either too large or too small. The containers do not have to be porous clay pots, but non-porous containers will not require as much water as the porous types.

When planting pots, place a piece of broken flower pot, convex side up, over the bottom drainage hole. Then pour a small amount of gravel or crushed rock, over this to insure drainage of surplus moisture. Hold the plant in the center of the pot while the soil is poured in between the roots until the pot is nearly full. As this is being done, the soil should be firmed down, either with the fingers or a blunt stick. The pots should be filled quite full as the soil will always settle a bit more. Never plant deeper than is necessary to hold the plant in position. If the plant will not stand up alone, put a slender stake beside it and tie it up until the plant is rooted and established.

Cactus and succulents may be planted in containers that do not have a drainage hole. In such cases, comparatively little water should be given. Care should be used in selecting plants for mixed dishes, to use only plants of similar light and water requirements. If the popular "tropical plants" are mixed in with cactus and succulents, one type will either get drowned or the other die of thirst. Dish gardens planted to properly selected, slow growing cactus, may be a delight and joy for years.

Globular and rosette types of plants should practically sit on the top of the soil. When potting is completed, water well and then go slow on watering until the plants are showing signs of new growth as evidenced by bright colored new spines or new leaves. If the proper size of pot is used to begin with, replanting into the next larger size of pot should be done about every two years. We do not consider it necessary to let the plants become pot bound to make them bloom. The soil that they are first potted in, should carry enough nourishment to last during the first year. When they begin to grow again in the second year, either commercial liquid or dry powdered fertilizers may be used. Be sure to follow the directions for feeding pot plants that are found on the package. Too much may be worse than none at all. Plants may be easily removed from tapered pots by placing a finger of the left hand on top of the soil on each side of the plant, turn the pot upside down and gently tap the rim on the edge of a table. The plant with its ball of earth, will drop out into the left hand. Before re-potting, break away the top layer of old soil but do not disturb the roots more than necessary.

Instructions as to watering are the hardest of all to give. The best rule of thumb, is to let the plants get dry enough for the soil to look dry when scratched, then water well. The interval

between waterings may vary from once a day for a two inch pot in the kitchen, to once a week or even longer, for a large pot in another location. Watering should be reduced to a minimum during the dark winter months. It should be remembered that the many Mexican kinds come from areas where there is no rain during our winter months. Watering should be reduced during long rainy or foggy periods at any time of the year. The Christmas cactus group should be allowed to dry out during September to encourage a resting period, after which, the flower buds will be formed.

Both cactus and succulents, should be put in the lightest possible place that is not in the full sun. If they are close to a window that is exposed to the hot afternoon sun, draw the lace curtains together during the hot hours. Plants that are in too much shade, will produce a growth that is stretched out or bleached in color. If the plants begin to grow towards the light, turn the pots around occasionally to offset this tendency. Many fanciers keep their plants in the house during the winter and then plunge the continers into a garden bed for the summer. Plants should not be suddenly moved from a shady place to full sun or they will sunburn badly. As a group, these plants should not be exposed to freezing temperatures. We find that when our neighbors growing oranges and lemons, have severe damage from cold weather, we suffer comparable losses. When grown in greenhouses, the humidity should be kept low. Humidity is not a problem in the house as our homes are usually quite dry.

Most of the diseases that affect cactus and succulents, are the soil borne fungus types that cause rotting from the base of the plant upward. These diseases are found everywhere, so it pays to heat treat the soil before using. The soil, almost damp enough to form a ball when squeezed, should be heated to a temperature of 180 degrees Fahrenheit and kept there for twenty minutes. If no other equipment is available, this may be done in an oven. Occasionally air borne diseases may cause rotten brown or black spots to appear on the bodies of the plants. In such cases, the diseased tissues should be cut or scraped out and the raw surface lightly dusted with a fungicide. The material sold under the trade name of "Captan" appears to be most effective for dusting the cut surfaces or spraying the whole plant.

The commonest pests are mealy bugs, scale and nematodes. There are several types of mealy bugs. The common white woolly one that attacks coleus and many other plants. There is one that is only found on cactus that is called the "spine mealy" which is a naked gray to brown insect. It is usually hidden in crevices or under the plants until it is time to reproduce, when it crawls out on the spines to form woolly white egg masses. Then there is the "root mealy" which lives entirely under ground. It works on the roots and forms powdery white deposits throughout the soil and on the insides of the pots. The commonest scales are insects which live under flat gray scales similar to the rose plant scales or larger hemispherical brown or black scales similar to fern scales. All of the foregoing pests may be eliminated from cactus by the use of sprays containing Malathion. Spraying should be repeated several times at two week intervals to insure a complete kill. For root mealy, drench the soil with the spray solution.

Malathion should not be used on succulents other than cactus unless it is known that they will stand it. Malathion is injurious to Crassulas, Echeverias and some other groups. For these plants an oil base spray such as Greenhouse Volck or the old time Black Leaf 40 nicotine spray are useful. Your garden supply center can give you more suggestions. For your own safety as well as that of the plants, always read and follow directions when using chemical materials.

Nematodes are minute worms that burrow into the roots and cause swollen lumps to appear upon them. After a time, these lumps or knots will rot and the plant may lose all its roots and starve to death. To eliminate nematodes, dig up the plants, cut off and burn the roots, wash the plant well, dry for a few days and replant in nematode free soil.

Hairy cactus should not be sprayed with either oil or nicotine sprays as these will cause the hair to become dirty. Discolored hairy plants may be cleaned up by washing with mild soap suds or a household detergent. Of course lay the plant on its side while washing to keep from soaking the soil with the solution.

Most cactus and succulent plants sold through the chain stores and similar outlets, have not reached flowering size. The large columnar types of giant cactus can never be brought to flowering size in the ordinary home. However there are many of the smaller groups that will blossom as house plants. Among these are: Astrophytums, Aporocactus, Coryphantha, Dolichothele, Echinocereus, Echinopsis, Epiphyllum (Phyllocactus), Hamatocactus, Lobivia, Malacocarpus, Mammillaria, Notocactus, Rebutia, Stenocactus, Thelocactus and Zygocactus.

Mammillarias usually have numerous small but bright flowers, followed by long red fruits some months later. Persons having a large collection of Mammillarias will find some kind in blossom almost every day in the year. The greatest portion of the cactus are spring and summer bloomers.

Gates Cactus, Inc., Corona, Calif.

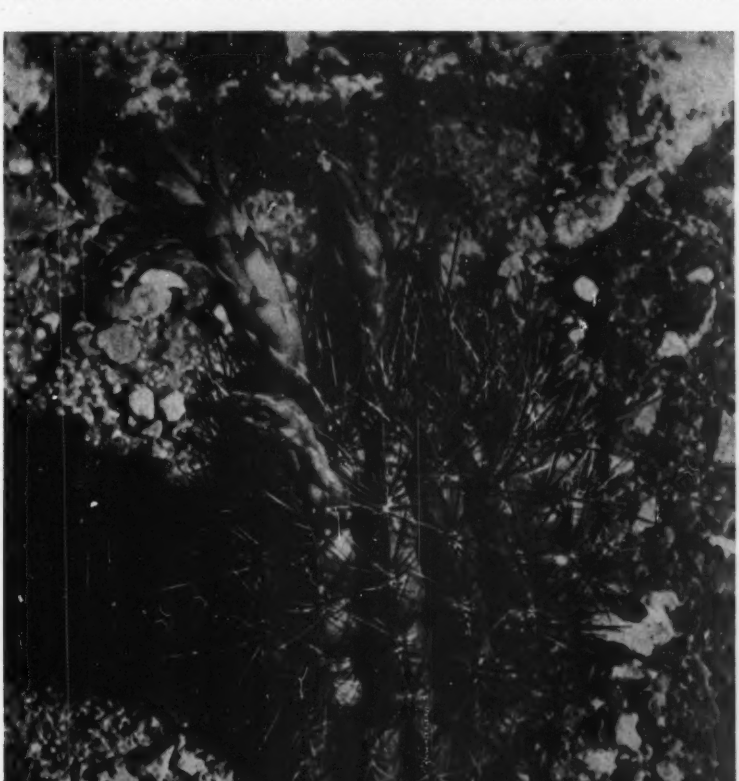


FIG. 63
Borzicactus calvescens Kimn. & Hutchis., the clonotype ca. 0.6. Photo by P. C. Hutchison.

ICONES PLANTARUM SUCCULENTARUM

10. *Borzicactus calvescens* Kimnach et Hutchison[1]

By MYRON KIMNACH AND P. C. HUTCHISON

Our plant of the new species here described grew in the glasshouse collection of the University of California Botanical Garden, Berkeley, for 20 years, but, as far as known, without ever flowering. When we first examined it, in 1954, we considered it to be *Oroya peruviana* (Schum.) Britt. & Rose, because of the shape of the podaria and, of the spination. Also, it resembled old, greenhouse-grown plants of *Oroya* in that it formed a short unbranched column, the lower half of which was dried and corky. It was noted, however, that the podarium was grooved and bore a protuberance similar to that of *Borzicactus aurantiacus* (Vaupel) Kimn. & Hutchis.,[2] although in the latter species the podaria are larger and the spines are thicker and less numerous.

The plant was collected in 1936 by James West in the Province of Santiago de Chuco, Department of Libertad, Peru, far north of the range of *Oroya peruviana*, but not far south of that of *B. aurantiacus*. West's notes describe the plants as globular, caespitose or rarely solitary, the older ones with 10 to 15 stems which average 10 to 15 cm. in width. He saw only one flower, which

1. University of California Botanical Garden, Berkeley, Contribution Number 147.
2. Kimnach, M. & P. C. Hutchison, Cact. & Succ. Journ. Amer. 29: 47, 1957.

was subapical, somewhat zygomorphic, crimson, with reflexed segment-tips, and with the bracteoles on the tube subtending neither spines nor hairs. All but one of these characters, the hairless receptacle, is found in *B. aurantiacus,* and as West was an accurate observer there seems to be no reason to doubt that hairs were truly absent. In other words West's morphological and distributional data supported our presumption of affinity of this species to *B. aurantiacus.*

In order to obtain flowers to complete identification, the apical portion of the plant was grafted on *Trichocereus spachianus* and planted outside in late summer. Within two months a dozen buds had formed, but the increasingly cold fall weather caused most of them to abort, despite the fact that the plant was covered nightly. It was then repotted, and, by keeping it over bottom heat in the glasshouse, a single flower was matured in January, 1956. It confirmed the other evidence that this plant was, indeed, closely related to *B. aurantiacus,* but was a new species differing, among other characters, in producing slightly hirsute or occasionally hairless flowers. After being replanted outdoors the next summer, the plant produced additional flowers. Our description is based on this living material.

Borzicactus calvescens Kimnach *et* Hutchison, *sp. nov. Plantae solitariae vel caespitosae; caules subglobosi, costis 16 vel 17, podariis octagonis super areolam minute sulcatis et infra areolam tuberculo minuto conico gerentibus; areolae ellipticae; spinae 25-35, flavo-brunneae, radiales subpectinatae usque ad 2 cm. longae, centrales erectae 4-8 usque ad 3.5 cm. longae; flores subapicales, anguste infundibuliformes, zygomorphici vel regulares, 6.5-8 cm. longi, limbo 3-5 cm. lato; receptaculum teres vel lateraliter compressum viridescens ad rubro-viride; bracteolae appressae deltoideae, marginibus concavis, acutae, flavo-virides ad rubescenti-brunneae, pilis in axillis nullis vel in axillis centralibus vel inferioribus saepe obviis ca. 10 albidis usque ad 1.5 mm. longis; tepala ca. 17, lanceolata ad oblonga subobtusa, medio aurantiaca, apice et marginibus purpureo-rubra; pars nectarifera tubi sine pilis staminodialibus; fructus teres vel lateraliter compressus viridescens costatus, basim versus longitudinaliter dehiscens; semina suboblonga, testa rugosa verrucosa, cellulis complanatis irregulariter oblongis, hilo oblique truncato, funiculo albo texto, strophiolo prominente nigrescente.*

Plant solitary or caespitose, *stems* globular, up to 15 cm. high and wide, the epidermis dark green, shiny; ribs vertical or slightly spiralled, completely divided into *podaria,* these up to 17 mm. in diameter, octagonal but with the upper center angle directed downward and connected to the areole by a groove up to 2 mm. long, evenly convex, highest just below the areole, with a 1 mm. long, obtusely or subacutely conical protuberance 1 mm. below young areoles; *areoles* variable in shape, 2 to 3 times longer than broad, 6 to 12 mm. long, 2 to 4 mm. wide, with short gray wool; *spines* 25 to 35, straight to barely curved, stiff, fading to light brownish yellow, the radials and centrals intergrading, the radials 0.5 to 2 cm. long, subpectinate, the uppermost 2 or 3 erect and straighter, yellowish with brownish bases, the centrals 4 to 8, 1.5 to 4 cm. long, up to *ca.* twice as thick as the radials, the uppermost ones usually the longest, brown.

Flowers borne on the upper half of the plant, radially distributed, erect to suberect, narrow-funnelform with a zygomorphic or regular limb, 6.5 to 8 cm. long, the limb 3 to 5 cm. wide; *receptacle* slightly curved, *ca.* 5 cm. long, the *pericarpel* 5 to 10 mm. long, 6 to 10 mm. wide, the remainder of receptacle 1 to 2 cm. wide, terete or often compressed dorso-ventrally; *podaria ca.* 12 (1 to 15) mm. long, ca. 5 (1 to 6) mm. wide, up to 2 mm. high, obtuse, the lowest ones green, the central ones pinkish bronze-green, the upper ones amber-pink; *bracteoles* acute, up to 15 mm. long and 5 mm. wide, the lower ones appressed, deltoid, the margins incurved, yellowish green, the upper ones transitional in shape, size, position and color to the outer tepals, the bracteole axils hairless or subtending up to 10 whitish hairs up to 2.5 mm. long, these present on the lower third, or more rarely on the lower two-thirds of the receptacle; *tepals ca.* 17, the outer ones lanceolate, acute, the inner ones elongate-oblong, subobtuse and minutely mucronate, 1.5 to 3 cm. long, ca. 6 mm. wide near the middle, orange-magenta along the center and at the base, the edges and apices magenta, the dorsal 3 erect and appressed to the stamens and stigma; *ovule-chamber* hemisphaerical, rarely obliquely so, *ca.* 3 mm. long, the funicles fascicled, free, unbranched, papillose; *nectary-chamber* oblate-spheroid, 3 to 4 mm. in diameter, the nectaries yellowish, deep pink on the upper half; primary *stamens* fused basally to form a slightly conical, flat, or inversely conical diaphragm surrounding and touching the style, then erect, tubular for 2 mm., then free and up to 4 cm. long, other stamens inserted on the diaphragm and pink receptacle wall up to the throat and there forming a throat-circle, the filaments *ca.* 1.5 cm. long, the basal 3 mm. coalescent, all filaments pink, or nearly white at the middle, the anthers *ca.* 1.5 mm. long, brownish yellow; *style* exceeding anthers by up to 1 cm., 5 to 7 cm. long, 1 mm. thick, pink, darkest on apical half, the stigma lobes 4 to 7, connivent,

FIG. 64

Borzicactus calvescens Kimn. & Hutchis., the clonotype. 1. Stem apex and flower, side view. 2. Flower, apical view. 3. Flower, longitudinal section, the stamens cut-off in one-half. 4. Nectary chamber. 5. Stigma. 6. Funicles. 7. Ripe fruit before dehiscence. 8, 9. Seed. 1-3,7, natural size. 4, 5, x 6. 6, greatly enlarged. 8, 9, x 20. Drawing by Mrs. M. Blos, 1957.

subulate, greenish yellow, 2 to 4 mm. long, heavily papillose on all faces.

Fruit subglobose or compressed laterally, 12 to 20 mm. long, up to 2 cm. wide, the bracteoles appressed, fleshy, yellowish green, tinged pink where exposed to sun, the podaria obtuse, up to 7 mm. long and wide, yellowish, tinged with brown and green, the axils with few or no hairs, perianth decurved, *ca.* 4 cm. long, reddish or brownish cream; *dehiscence* by longitudinal splitting near the base at one or more points.

Seed suboblong with an obliquely truncate hilar end, 1.5 to 2.2 mm. long, *ca.* 1.5 mm. wide and *ca.* 1 mm. thick, the testa black, verrucose and obscurely rugose; the cells flattened and irregularly shaped, smaller and rounded near the hilum, oblong, the brownish white funicle-tissue covering the deeply sunken micropyle and black hilar testa, the strophiole slightly protruding, blackish, conical, obtuse.

Peru, Dept. La Libertad, Prov. Santiago de Chuco, near a coal mine below Arenillas (*ca.* 15 km. north of Angasmarca), on rock outcrops on open, grassy hills at *ca.* 3700 m., collected on Dec. 1, 1936, James West 8176, *University of California Botanical Garden 37.1101* (UC-Holotype, US).

West noted that he saw the species at various localities northward to Cerro Marcahuamachuco and westward to Quiruvilca.

The primary differences between *B. calvescens* and its closest known ally, *B. aurantiacus,* are as follows:

	B. calvescens UCBG 37.1101	*B. aurantiacus* UCBG 53.486
Podaria	ca. 1.5 cm. wide	ca. 3 cm. wide
Spines	25-35	20-30
radials	0.5-2 cm. long	2-2.5 cm. long
centrals	1.5-3.5 cm. long	2.5-4.5 cm. long
Flowers	zygomorphic or regular	zygomorphic
receptacle	terete or compressed, greenish brown	terete, amber-orange
central bracteoles	ca. as long as broad	at least twice as long as broad
receptacle hairs	lacking, or up to 10 from an areole, up to 2 mm. long	40-50 from an areole, up to 7 mm. long
tepals	6 mm. wide, magenta and orange	10 (holotype 5-7) mm. wide, orange-yellow
hair-ring	lacking	usually present
Fruit	terete or compressed, greenish	terete, brownish
Seed	ca. 1.5 mm. long, narrowed near hilum, black, cells flattened and irregularly oblong, hilum strongly oblique, in lateral view strophiole not visible	ca. 2 mm. long, not narrowed near hilum, brownish, cells protruding and circular, hilum slightly oblique, in lateral view strophiole conspicuous

These differences are not impressive, and it may be necessary to reduce *B. calvescens* to varietal status under *B. aurantiacus* when more is known of variation in *Borzicactus* species. However the distinctions noted above or illustrated in the drawings of these two species, particularly those differences of bracteoles, petals, ovules, funicles and seed, are not usual within species of this genus so far as is presently known. Some clarification of the status of *B. calvescens* and related species should result from field investigations in Peru scheduled for July to November of this year.[3]

The most unusual character of *B. calvescens* is the variability of flowers on a single individual. for example, zygomorphy and actinomorphy occur with equal frequency, both conditions apparently being influenced by bud-position. Thus, if flowers develop on the northern side of

3. University of California Sixth Botanical Garden Expedition to the Andes, 1957-1958.

the plant and open facing in that direction they will usually be regular, especially if they are erect from having originated near the stem apex; on the other hand, those facing to the south are highly zygomorphic, especially if they have emerged from the lower areoles and have therefore assumed a more horizontal position. Evidently light and gravitation strongly influence the degree of zygomorphy in some cacti, particularly in *Borzicactus* and its allies. Buxbaum has stated (oral communication) that in this group zygomorphy is largely determined by the lateral position of the flower on the stem. We have noted that erect stems of *Bolivicereus samaipatanus* Cárd. var. *multiflorus* Cárd. produce flowers which are nearly horizontal and with an extremely oblique limb, yet when we kept a stem-cutting in a horizontal position an erect half-grown bud matured with a perfectly regular limb.

A second variable floral character of this new species is the shape of the receptacle (and, consequently, of the fruit), which may be either terete or strongly compressed dorso-ventrally. The reason for this variation is obscure and its occurrence seems to have no connection with that of zygomorphy of the limb. The flowers of the genera *Seticereus* Backeb. and *Oreocereus* (Berg.) Riccob. (both of which genera we believe should be reduced to *Borzicactus*) are also usually compressed laterally, and it is possible that this is caused by compression of the bud by the profuse bristles of the flowering areoles. It is also possible that the compressed flowers of *B. calvescens* are the result of pressure on the buds by developing spines.

A third important variable character of flowers from one plant of this species is the degree of hirsuteness of the receptacle. The most hirsute flowers appear late in the flowering season, during colder weather, and the hairs may be present on as much as the lower two-thirds of the tube. At this extreme of development the hairs are much shorter and less profuse than those of *B. aurantiacus*, and in *Borzicactus* and its allies are less developed only in *Oroya peruviana*, *Matucana haynei* (Otto) Britt. & Rose and *M. weberbaueri* (Vaup.) Backeb. During warm weather the buds grow faster and apparently complete their growth more quickly than do the hairs, for when they mature, the hairs are short and confined to the lower part of the tube or may be lacking altogether. We have named the species for this occurrence of both hirsute and hairless flowers (*calvescens*: becoming bald, balding).

Matucana haynei also is reported to have hairless flowers, and the genus *Matucana* Britt. & Rose was originally distinguished from *Arequipa* Britt. & Rose primarily on this character. But we have observed several plants of *M. haynei* to have occasional flowers with minute bristles in the axils of the lower bracteoles. The flower, fruit and seed of this species show it to be closely related to *B. calvescens*, and it is obvious that *Matucana* can no longer be maintained merely on the basis of the lack of receptacle hairs. In following the criteria of Britton and Rose or of Backeberg in distinguishing these genera it would be necessary to classify *B. calvescens* and *M. haynei* as belonging to *Matucana* part of the year and to *Arequipa* at other times, depending on the hirsuteness of individual flowers. For distinguishing genera in the Cactaceae such quantitative characters are highly suspect, particularly when used alone. If *Matucana* is recognized at all it should include all the globular species of *Borzicactus* of central and northern Peru, excepting *Oroya, i.e., Borzicactus calvescens, B. aurantiacus, Matucana weberbaueri, M. haynei* and *Echinocactus myriacanthus* Vaup., all of which we believe have originated along a widely separate phyletic line from that from which the type species of *Arequipa, Echinocactus leucotrichus* Philippi, had its origin. Evidence supporting this conclusion will be presented later.

The cultural requirements of the new species seem identical with those of *B. aurantiacus*. According to our experience it will flower well only if grown outdoors. Its flowers do not have as large a limb as the plants of *B. aurantiacus* collected by Blossfeld (cf. footnote 2), but they are freely produced and of an attractive magenta shade. Unfortunately, the flowering season is somewhat short and has so far occurred during our late fall and early winter so that cold weather may restrict or damage the blooms, as noted above. As only this one clone is known to be in cultivation, we are propagating it vegetatively so that it may be distributed to other collections.

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EDITOR'S NOTE

This issue of the JOURNAL has been produced in spite of the Convention! The next issue will continue the regular features and the continuation of Marjorie Shields' popular series, "Desert Flowers Under Glass". There will be a report of the Convention; the closing date was too close to the publication date to be included in this issue.

HOMER RUSH

Just as we were going to press we learn of the death of Homer Rush on June 7. The cactus world has lost a real friend. There will be an obituary in the next JOURNAL.